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ORIGINAL ARTICLE

Adaptation and validation of the Mood Rhythm Instrument for use in Brazilian adolescents

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Objective: Adapt and validate the Mood Rhythm Instrument (MRhI), a self-reported questionnaire that assesses self-perceived rhythmicity of mood-related symptoms in adults, into a version that assesses and evaluates perceived mood-related symptoms in adolescents (MRhI-Y).
Methods: Adaptation of the Brazilian Portuguese version of the MRhI for an adolescent population followed three steps: review by consultants, analysis by experts, and pilot testing through a visual analogue scale (VAS). The final questionnaire (MRhI-Y) was applied to 171 adolescents aged 12-17 years. Internal consistency was calculated using Cronbach's alpha and McDonald's omega. The psychometric properties of the MRhI-Y were evaluated using exploratory factor analysis (EFA).
Results: The MRhI-Y was designed to use wording more appropriate for adolescents than that of the MRhI. Expert agreement about item quality ranged between 82 and 100%. Adolescents' VAS ratings indicated good comprehension of the items. Cronbach's alpha and McDonalds' omega coefficients were 0.71 and 0.74. The EFA resulted in a three-factor solution (affective, cognitive, and somatic). Younger adolescents (ages 12 to 13) reported lower rhythmicity scores than older groups (ages 14 to 15 and 16 to 17), even controlling for chronotype.
Conclusions: The Brazilian Portuguese version of the MRhI-Y presented adequate comprehension by adolescents and good internal consistency. The MRhI-Y is a promising tool to improve our understanding of the underlying characteristics of mood fluctuation in adolescence.

Keywords: Chronobiology; mood; adolescents; circadian rhythms

Introduction

In mammals, the circadian system synchronizes the rhythm of several cellular and physiological functions with the light-dark cycle.[1,2] There is a large body of research showing that circadian rhythms are important for diverse behavioral and neurobiological functions, such as mood, memory, motor activity, hormone secretion, temperature, food intake, and sleep.[3,4] Additionally, there are studies linking circadian system alterations to mood impairment[5-8] and mood disorders.[9,10] Nevertheless, little is known about the rhythmicity of other behavioral and physiological functions, such as appetite, sadness, irritability, self-esteem, and cognitive abilities.

Studies evaluating mood or behavioral circadian rhythmicity are scarce in populations of adolescents. One explanation for this knowledge gap is the absence of validated assessment tools for such a purpose. Recently, the Biological Rhythms Interview for Assessment in Neuropsychiatry was validated in children and adolescents (BRIAN-K) to evaluate biological patterns in four domains: sleep, activity, social, and eating. However, the BRAIN-K does not measure self-reported rhythmicity or self-perception of daily peaks of mood symptoms in adolescents.[11] The Mood Rhythm Instrument (MRhI) has been recently developed to assess self-perceived mood rhythmicity. Recent studies have shown that a higher number of items perceived as having daily peaks in MRhI were associated with higher scores of depressive symptoms and lower scores on well-being.[12] Also, self-perceived rhythmicity in MRhI, particularly in "pessimism" and "motivation to exercise," was associated with a higher risk of having a psychiatric disorder.[13]

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The MRhI is a valuable tool for clinical and epidemiological research, as it provides information on core aspects of mood-related symptoms and behaviors. This study describes the validation steps of the MRhI into a version for adolescents (MRhI-Y), including testing of the psychometric properties of the MRhI-Y in Brazilian adolescents.

Methods

The MRhI is a self-report questionnaire that assesses self-perceived rhythmicity and peak of mood symptoms over 24 hours in the past 15 days. Its 15 items cover cognitive, affective, and somatic domains.[14] When a person answers "yes" to a daily peak in any MRhI item, they are also asked to report the time of day at which the peak occurs. The sum of categorical variables provides a total score that ranges from 0 to 15 (0 representing no perceived rhythmicity, and 15 denoting rhythmicity in all variables). The MRhI does not seem to be affected by memory bias recall,[12] and its Cronbach's alpha coefficients were 0.70, 0.73, and 0.79 for the Portuguese,[14] Spanish,[15] and English versions,[16] respectively. The MRhI has already been validated for adults in Brazilian Portuguese.[12-14,17] We also applied the Puberty and Phase Preference Scale, a self-reported questionnaire used to measure chronotype through questions about schedule preferences. The higher the score, the greater the respondent's morningness; the lower the score, the greater their eveningness. A Brazilian Portuguese version was used in this study.[18]

Adaptation from the adult version (MRhI) to an adolescent version (MRhI-Y)

Initially, a group of experts adapted the original MRhI scale into a new version for adolescents (MRhI-Y). This multidisciplinary team was composed of a certified child and adolescent psychiatrist, two clinical psychologists, an adult psychiatrist, two biomedical scientists, two medical students, one psychology student, and one biomedical science student.

The working group created a new version of the MRhI by adapting each question to be comprehensive and appropriate for adolescents' sociocultural aspects. Then, certified child and adolescent psychiatrists were invited to evaluate the MRhI-Y. All 14 items were analyzed according to verbal comprehension (if the question was easy to understand), verbal fluency (if the question was written in the best possible way), clarity (if the question was clear), straightforwardness (if the question was direct), simplicity (if the question was formulated in the simplest way to ask it), relevance (if the question was relevant to adolescents), and focus (if the question had only one focus).[19,20] The specialists reported whether they agreed or not with each criterion. Agreement higher than 80% between two specialists was considered adequate.[19,20] The specialists were also able to make suggestions to improve the questionnaire further. Then, to assess item clarity, 19 adolescents were randomly invited from among the sample of 171 adolescents to rate the questions using a visual analogue scale (VAS) from 0 (not clear) to 10 (very clear). The expert panel discussed the specialists' suggestions and the clarity of items until consensus was reached; all the necessary adjustments resulted in the final version of the MRhI-Y.

Finally, the research group administered the final questionnaire to a sample of 171 adolescents (12-17 years old) attending grades 6-12 at a public school in the state of Rio Grande do Sul, Brazil. The sample was composed of 92 males (53.8%) and 79 females (46.2%). The mean age was 14.19 ± 1.58. The proportion of participants studying in the morning was 57.7%, and in the afternoon, 42.3%. There were no differences between males or females in age or percentage of students studying in the morning or afternoon. The exclusion criteria were inability to complete or understand the questionnaire or signature of informed dissent by the students and their parents.

Statistical analysis

Categorical variables were expressed as absolute and relative frequencies. Continuous variables were expressed as mean and standard deviation. Variables were tested for normality using the Shapiro-Wilk test. Comparisons of the frequency of the dichotomous MRhI-Y items according to sex were done by a chi-square test (χ^2). MRhI-Y time peak is shown as mode, and is also graphically represented using Rayleigh graphs compared by sex. Rayleigh graphs are clock-like distributions of circular data; the value for each individual is plotted around a circumference that represents a range of 24 hours. We compared the rhythmicity between different age groups using analysis of variance (ANOVA), and controlled for chronotype using analysis of covariance (ANCOVA). The instrument's internal consistency was calculated using Cronbach's alpha and McDonalds' omega, with alpha and omega values $\geqslant 0.7$ deemed satisfactory indicators of internal consistency.[21-23]

The psychometric properties of the MRhI-Y were evaluated using exploratory factor analysis (EFA). Since our data are binary, the EFA was carried out using a tetrachoric correlation matrix, with weighted least squares (WLS) extraction and oblimin rotation.[24,25] To define the number of factors to be retained, we used Horn's parallel analysis, because it is based on the comparison of eigenvalues of the actual data to those of the simulative data.[26,27] For comparison correction for the analyses, we used the Benjamini-Hochberg step-up false discovery rate method. Statistical analyses were conducted in PASW Statistics, Version 18 (SPSS Inc., Chicago, USA), R version 3.4.1 (package "psych"), and WINPEPI version 11.65. Statistical significance was accepted at $p < 0.05$.

Ethics statement

The study was approved by the Hospital de Clínicas de Porto Alegre ethics committee (18-0068 GPPG/HCPA) and was conducted in accordance with the declaration of Helsinki. All potential participants received an informed dissent to be signed by their parents if they disagreed with the adolescent's participation in the study. Participants

who did not return the informed dissent signed by their parents were included.

Results

Step 1: adaptation process

The original MRhI items were rephrased based on the experts' recommendations, considering a lexicon and grammatical complexity more appropriate to adolescents. A few synonyms for uncommon words were also added. The expert panel reiterated the main important instructions, "Regarding the previous 15 days...," "If you answer yes, indicate below the approximate hour," and "Mark only one line" in all questions to make them clearer and easier to follow. Furthermore, researchers added a few examples on how to fill in the items to make the process more understandable. To enhance reliability and participation, researchers decided to exclude the question related to libido, to avoid misunderstandings and refusal to fill out the questionnaire. This choice was based on certain taboos raised around the subject and the variety of connotations regarding sexual content in youth. The score sum for all factors (verbal comprehension, verbal fluency, clarity, straightforwardness, simplicity, credibility, and focus) given by the child and adolescent psychiatrists ranged between 0.82 to 1.00, which indicates high agreement.[19] Adolescents' VAS scores for each question ranged from 8.65 to 9.19, which indicates good comprehension of the items. The final version of the MRhI-Y is available as online-only supplementary material.

Step 2: reliability and validity

In this sample, McDonalds' omega reliability index was 0.74 and Cronbach's alpha coefficient was 0.71, suggesting adequate internal consistency. The actual data and the simulative data underwent Horn's parallel analysis, which yielded a three-factor model solution. Factor analysis of the categorical MRhI-Y items and their factor loadings are presented in Table 1. All factor loads obtained were between 0.47 and 0.79. The three-factor model solution represented good content validity regarding their group meaning in each factor. Values above 0.40 have been taken as acceptable representations of the factor.[28] The item talk to friends presented a loading factor that was identical in two factors and a maximum load value of 0.30; therefore, we chose to exclude this item from the MRhI-Y. The first factor (cognitive) comprised physical exercise, energy, alertness, problem-solving, self-esteem, concentration, and memory.

Table 1 Exploratory factor analysis (EFA) of the Mood Rhythm Instrument, Youth version (MRhI-Y), based on a three-factor model

	EFA with all variables			EFA after excluding "Talk to friends"		
Questions	Factor 1 (cognitive)	Factor 2 (affective)	Factor 3 (somatic)	Factor 1 (cognitive)	Factor 2 (affective)	Factor 3 (somatic)
Alertness	0.49	-0.13	0.24	0.51	-0.12	0.24
Sleepiness	0.10	0.04	0.65	0.12	0.05	0.59
Solving problems	0.44	0.14	0.14	0.44	0.13	0.12
Self-esteem	0.49	0.23	-0.28	0.47	0.22	-0.28
Concentration	0.69	0.09	0.03	0.69	0.17	0.03
Appetite	0.05	0.08	0.60	0.07	0.08	0.63
Irritability	0.17	0.67	-0.03	0.17	0.66	-0.03
Anxiety	-0.15	0.54	0.31	-0.14	0.54	0.32
Sadness	0.08	0.80	0.00	0.09	0.81	0.00
Physical exercise	0.52	-0.22	0.08	0.52	-0.22	0.07
Memory	0.51	0.02	0.11	0.52	0.03	0.13
Pessimism	-0.13	0.76	0.02	-0.13	0.76	0.02
Talk to friends†	0.30	0.30	0.21	†	†	†
Energy	0.76	-0.02	-0.02	0.76	-0.01	-0.02
Eigenvalues	2.51	2.29	1.22	2.41	2.18	1.10
Variance explained (%)	42	38	20	42	38	19

Gray-shaded cells indicate the factor to which each item belongs.
† Excluded item.

The second factor (affective) comprised irritability, anxiety, sadness, and pessimism. The third factor (somatic) included sleepiness and appetite. The factor that explains most of the variance belongs to the cognitive factor, followed by the affective factor and, lastly, the somatic factor.

Figure 1 displays the comparison between sexes and age groups for the frequency of rhythmicity for each MRhI-Y item. Alertness ($p = 0.013$) and physical exercise ($p < 0.001$) were significantly more rhythmic in males. The female respondents self-reported a higher presence of perceived rhythmicity in problem-solving ($p = 0.042$), appetite ($p = 0.002$), anxiety ($p = 0.002$), and sadness ($p = 0.005$). However, the finding related to the problem-solving item did not survive to multiple comparison correction. Sadness, memory, and pessimism were the only variables for which rhythmicity was < 50% in the total sample. Females and males had similar peak modes in the morning for self-esteem, concentration, memory, and appetite. Besides, males had a peak time in the morning for irritability and alertness, while females reported a peak for anxiety and energy. In the afternoon, both sexes had similar modes for motivation to exercise, pessimism, sleepiness, solving problems, and talk to friends. In the evening, males showed modes for sadness, anxiety, energy, and talk to friends; females showed modes for sadness, irritability, alertness, problem solving, and memory (Table 2). Most of the variables showed more than one mode (Figure 1).

Figure 2 shows the Rayleigh graphs for each MRhI-Y item. Using the Watson-Williams test, we found that males had significant later perceived peaks for alertness and sadness, as well as earlier peaks for self-esteem and concentration, compared to females. After multiple-comparison correction, the perceived peak for the concentration item did not differ between males and females, while all other previous findings remained statistically significant (Table 3).

The age was categorized into three groups (12-13, 14-15, and 16-17 years old). We calculated a rhythmicity score with the sum of items in the MRhI-Y that presented perceived rhythmicity during the day. Our sample presented a mean total rhythmicity of 8.78 ± 2.96 (mean $\pm$ standard deviation [SD]). Using ANOVA, we found that adolescents aged 12-13 years presented a total score of perceived rhythmicity of 7.53 ± 3.03, which was significantly lower than in those aged 14-15 (9.21 ± 2.57; $p = 0.004$) and 16-17 (9.65 ± 3.02; $p = 0.001$). There was no significant difference in mean perceived rhythmicity between the groups aged 14-15 and 16-17 years. This finding suggests that younger adolescents showed lower perceived rhythmicity scores on MRhI-Y than the older ones. Even controlling for chronotype using ANCOVA, age was still significantly related to the perceived rhythmicity ($F_{2,157} = 6.823$, $p = 0.001$), while chronotype was not ($F_{1,157} = 0.451$, $p = 0.503$).

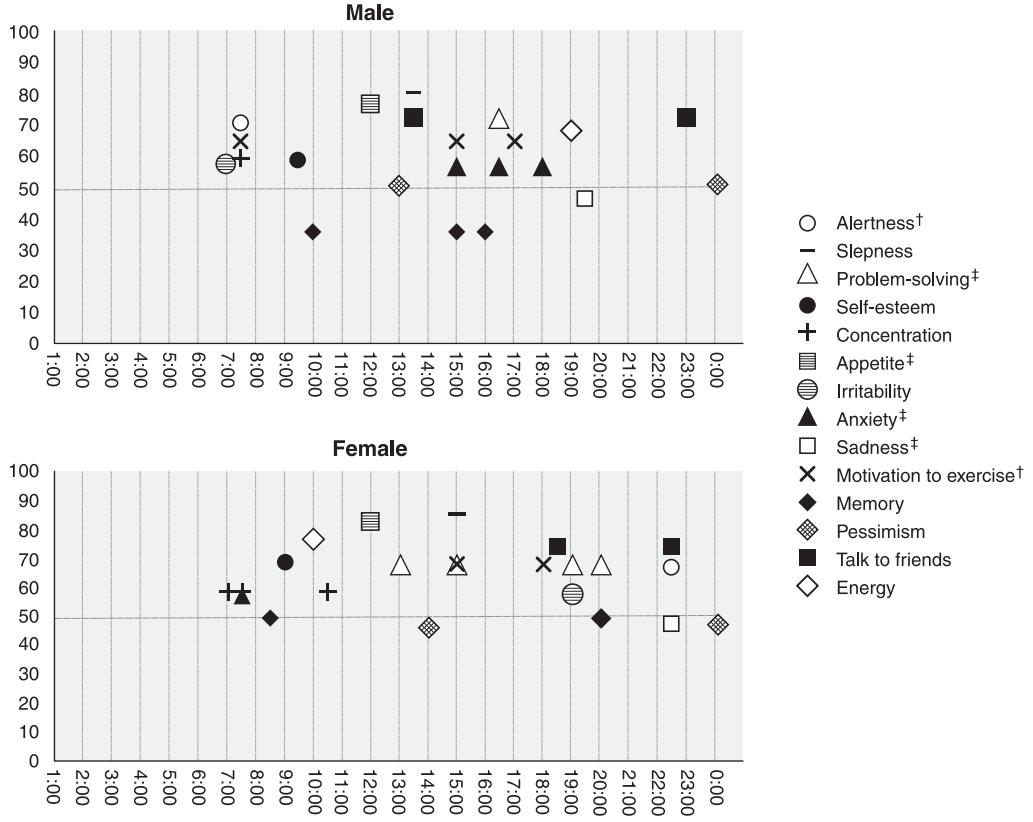

Figure 1 Frequency of perceived rhythmicity of each item and the mode of the daily peak for males and females. Some variables depict more than one mode. † Significantly more rhythmic in males. ‡ Significantly more rhythmic in females.

Table 2 Frequency of reported rhythmicity of the MRhI-Y items

MRhI-Y item	Rhythmic (yes)			χ^2	p-value	Benjamini-Hochberg step-up FDR method-adjusted p-value
	Total 171 (100.0)	Male 92 (53.8)	Female 79 (46.2)			
1. ... alertness...	116 (68.6)	70 (76.9)	46 (59)	**5.48**	**0.013**	**0.036**
2. ... sleepiness...	137 (82.5)	71 (79.8)	76 (85.7)	0.64	0.413	-
3. ... disposition to solve everyday problems...	117 (70.1)	56 (62.9)	61 (78.2)	**3.93**	**0.042**	0.098
4. ... self-esteem...	97 (58.8)	52 (57.8)	45 (60.0)	0.17	0.874	-
5. ... concentration...	105 (63.3)	55 (61.8)	50 (64.9)	0.66	0.748	-
6. ... appetite...	133 (79.2)	63 (70.0)	70 (89.7)	**8.71**	**0.002**	**0.009**
7. ... irritation...	96 (57.5)	49 (54.4)	47 (61.0)	0.49	0.434	-
8. ... anxiety...	94 (56.6)	40 (44.9)	54 (70.1)	**9.66**	**0.002**	**0.009**
9. ... sadness...	78 (46.7)	33 (36.7)	45 (58.4)	**7.04**	**0.005**	**0.017**
10. ... more prone to do physical exercise...	112 (66.3)	72 (79.1)	40 (51.3)	**13.34**	**< 0.001**	**0.001**
11. .... higher capacity to memorize...	70 (41.9)	36 (40)	34 (44.2)	0.15	0.638	-
12. ... pessimism...	82 (48.5)	42 (46.2)	40 (51.3)	0.26	0.539	-
13. ... talk to friends...	123 (71.9)	65 (71.4)	58 (75.3)	0.15	0.604	-
14. ... more energy...	122 (72.2)	67 (73.6)	55 (70.5)	0.08	0.731	-

Data presented as n (%), unless otherwise specified. Bold type denotes statistical significance.
FDR = false discovery rate; MRhI-Y = Mood Rhythm Instrument, Youth version.

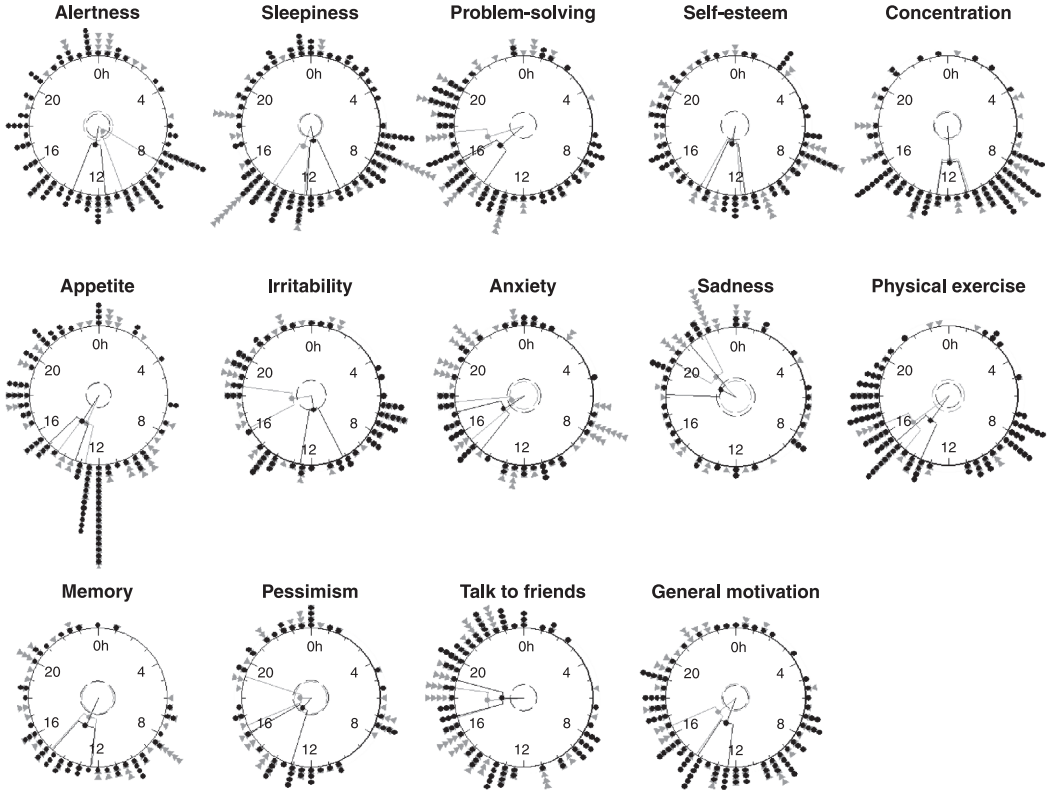

Figure 2 Rayleigh graphs.Black and grey spots are the representation of the perceived peaks for males and females, respectively.

Discussion

This study describes the process of adaptation and validation of the MRhI into a version for adolescents aged 12-17 years, the MRhI-Y. The main modifications to the original scale involved synonyms and examples that facilitated the adolescents' understanding of the items. Factor analysis of the MRhI-Y showed a three-factor structure (cognitive, affective, and somatic).

By investigating self-perceived rhythmicity of mood-related symptoms in an adolescent sample, we observed some interesting similarities and differences in comparison to previous studies in adults.[13,14] For instance, as previously observed in adults, sleepiness was the most

Table 3 Comparison of perceived peak times between males and females

MRhI-Y item	Male peak (h)	Female peak (h)	p-value	Benjamini-Hochberg step-up FDR method-adjusted p-value
1. ... alertness...	3:36 p.m.	10:00 a.m.	**0.004**	**0.018**
2. ... sleepiness...	1:48 p.m.	3:36 p.m.	0.070	-
3. ... disposition to solve everyday problems...	5:54 p.m.	5:24 p.m.	0.659	-
4. ... self-esteem...	11:12 a.m.	4:00 p.m.	**< 0.001**	**0.001**
5. ... concentration...	11:36 a.m.	2:12 p.m.	**0.026**	0.286
6. ... appetite...	3:30 p.m.	3:42 p.m.	0.839	-
7. ... irritation...	4:00 p.m.	4:00 p.m.	0.983	-
8. ... anxiety...	4:42 p.m.	6:54 p.m.	0.235	-
9. ... sadness...	10:18 p.m.	6:30 p.m.	**< 0.001**	**0.001**
10. ... more prone to do physical exercise...	4:24 p.m.	2:18 p.m.	0.065	-
11. .... higher capacity to memorize...	2:30 p.m.	3:48 p.m.	0.631	-
12. ... pessimism...	6:30 p.m.	4:48 p.m.	0.103	-
13. ... talk to friends...	7:54 p.m.	7:36 p.m.	0.787	-
14. ... more energy...	3:54 p.m.	4:54 p.m.	0.526	-

The median time was found by converting hours to radians for Watson-William analysis. The mean time for the participants is described as the time of day (a.m./p.m.). Bold type denotes statistical significance.
FDR = false discovery rate; MRhI-Y = Mood Rhythm Instrument, Youth version.

rhythmic variable in adolescents, and appetite also had one of the highest perceived rhythmicities compared to other mood-related variables. On the other hand, while the peak of the cognitive items clustered in the morning in adults, they were spread throughout the day and night in adolescents. These findings are consistent with previous studies reporting a rhythmic nature of cognitive functions in all age groups,[29] with their peaks occurring at different times of the day. Generally, peaks of cognitive functions in morning-type persons are more frequently reported in the morning, whereas evening-types tend to report them more in the evening,[30] a physiological characteristic that changes as a function of age. Frequently, adolescents are evening-oriented, while adults are more prone to report morningness.[31] In addition, our sample of adolescents perceived a peak for affective items more frequently than adults.[13] Factor analysis demonstrated that the variable talk to friends presented a low loading factor. The MRhI-Y is designed to assess mood rhythmicity, and we believe the ''talk to friends'' item may be assessing not mood rhythmicity, but social rhythmicity – a different construct that needs to be explored further, since we do not have a valid instrument to assess it. Talk to friends was perceived as rhythmic in adolescents with a much higher frequency (70%) than in adults ($<$ 32%). It is conceivable that being connected with one's friends may be more important for adolescents than for adults.[32] Therefore, the rhythmicity around relationships may be more essential for adolescents in order to maintain their social network, although even being important, it seems to not be related to the mood rhythmicity construct.

Age-dependent changes in the circadian phase have been reported for physiological rhythms.[33] In this study, some behaviors were also described as potentially age-dependent characteristics: frequency and the multimodal distribution of the perceived peak. The total perceived rhythmicity in adolescents aged 12-13 years was significantly lower than in the other age ranges. Also, unlike adults, who had one peak mode for each variable, adolescents demonstrated more than one peak mode for most items.[14] One possible explanation for the increase in self-perceived rhythmicity and decrease in older adolescents' multimodal distribution could be the brain maturation process. Adolescence is a phase where cerebral maturation, body changes, and physiological and behavioral adaptations occur.[34] Pubertal development is known to correlate with shifts in the circadian phase.[35] Older adolescents are more prone to engage in activities later in the day.[31] However, in the MRhI-Y items for males, the only perceived peak late in the day was alertness. Talk to friends, sadness, appetite, concentration, and self-esteem showed similar perceived peaks between males and females; in all other items, peaks occurred later in the day for females. Since the pubertal stages[36] may affect the behavior and mood pattern of adolescents, future studies should evaluate the participants' pubertal phase.

As our study was performed among adolescents in a low-income region, its external validity is limited to this population. It is important to assess sensitivity and specificity in other countries, cultures, and socioeconomic backgrounds. Understanding the physiological self-perception of mood rhythmicity can help future researchers look for markers that could indicate a higher predisposition to mood disorders, or early signs of a mood episode. Finally, studies in clinical samples are crucial to uncovering potential differences between adolescents with and without mood disorders. In the context of mood disorders in adolescence, several studies have already proved the relevance of research into biological rhythms.[8,37-39] Adolescents with depression showed a higher preference toward the eveningness chronotype, lower activity average, and an earlier peak for the most active hour during the day compared to controls.[37] Another study found an association with eveningness chronotype in adolescents with decreased separation anxiety, elevated symptoms of depression, and low levels of positive affect.[38] In this context, the MRhI-Y may become an important additional tool for the objective assessment of normal and pathological perceptions of mood variations, hence contributing to the diagnosis and treatment of mood disorders in this age range.

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Disclosure

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References

1 Reppert SM, Weaver DR. Coordination of circadian timing in mammals. Nature. 2002;418:935-41.
2 Roenneberg T, Kumar CJ, Merrow M. The human circadian clock entrains to sun time. Curr Biol. 2007;17:R44-5.
3 Monteleone P, Maj M. The circadian basis of mood disorders: recent developments and treatment implications. Eur Neuropsychopharmacol. 2008;18:70111.
4 Monteleone P, Martiadis V, Maj M. Circadian rhythms and treatment implications in depression. Prog Neuropsychopharmacol Biol Psychiatry. 2011;35:1569-74.
5 Schnell A, Albrecht U, Sandrelli F. Rhythm and mood: relationships between the circadian clock and mood-related behavior. Behav Neurosci. 2014;128:326-43.
6 Melo MC, Abreu RL, Linhares Neto VB, de Bruin PF, de Bruin VMS. Chronotype and circadian rhythm in bipolar disorder: a systematic review. Sleep Med Rev. 2017;34:46-58.
7 Faria AD, de Azevedo Cardoso T, Mondin TC, de Mattos Souza LD, da Silva Magalhaes PV, Zeni CP, et al. Biological rhythms in bipolar and depressive disorders: a community study with drug-naïve young adults. J Affect Disord. 2015;186:145-8.
8 Dueck A, Berger C, Wunsch K, Thome J, Cohrs S, Reis O, et al. The role of sleep problems and circadian clock genes in attention-deficit hyperactivity disorder and mood disorders during childhood and adolescence: an update. J Neural Transm (Vienna). 2017;124:127-38.
9 Nguyen C, Murray G, Anderson S, Filipowicz A, Ingram KK. In vivo molecular chronotyping, circadian misalignment, and high rates of depression in young adults. J Affect Disord. 2019;250:425-31.
10 Evans JA, Davidson AJ. Health consequences of circadian disruption in humans and animal models. Prog Mol Biol Transl Sci. 2013; 119:283-323.
11 Berny T, Jansen K, de Azevedo Cardoso T, Mondin TC, da Silva RA, de Mattos Souza LD, et al. Construction of a biological rhythm assessment scale for children. Trends Psychiatry Psychother. 2018;40:53-60.
12 Pilz LK, Carissimi A, Francisco AP, Oliveira MA, Slyepchenko A, Epifano K, et al. Prospective assessment of daily patterns of mood-related symptoms. Front Psychiatry. 2018;9:370.
13 Pilz LK, Carissimi A, Oliveira MA, Francisco AP, Fabris RC, Medeiros MS, et al. Rhythmicity of mood symptoms in individuals at risk for psychiatric disorders. Sci Rep. 2018;8:11402.
14 de Souza CM, Carissimi A, Costa D, Francisco AP, Medeiros MS, Ilgenfritz CA, et al. The mood rhythm instrument: development and preliminary report. Braz J Psychiatry. 2016;38:148-53.
15 Francisco AP, de Oliveira MA, Carissimi A, Fabris RC, Ilgenfritz CA, de Souza CM, et al. Spanish translation of the mood rhythm instrument: a novel approach to mood evaluation. Clin Biomed Res. 2017;37:41-47.
16 Oliveira MA, Epifano K, Mathur S, Carvalho FG, Scop M, Carissimi A, et al. Validation of the English version of the mood rhythm instrument. BMC Psychol. 2020;8:35.
17 de Oliveira MA, de Mendonça Filho EJ, Carissimi A, Dos Santos Garay LL, Scop M, Bandeira DR, et al. The revised mood rhythm instrument: a large multicultural psychometric study. J Clin Med. 2021;10:388.
18 Finimundi M, Barin I, Bandeira D, Souza DO. Validação da escala de ritmo circadiano - ciclo vigília/sono para adolescentes. Rev Paul Pediatr. 2012;30:409-14.
19 Pasquali L. Instrumentos psicológicos: manual prático de elaboração. Brasília: LabPAM/IBAPP; 1999.
20 Pasquali L. Instrumentação psicológica: fundamentos e práticas. Porto Alegre: Artmed; 2010.
21 Tavakol M, Dennick R. Making sense of Cronbach's alpha. Int J Med Educ. 2011;2:53-5.
22 Marôco J. Análise de equações estruturais: fundamentos teóricos, software & aplicações. 2nd ed. Edn Pêro Pinheiro: ReportNumber; 2014.
23 Nunnally JC. An overview of psychological measurement. In: Wolman BB, editors. Clinical diagnosis of mental disorders. Boston: Springer; 1978. p. 97-146.
24 Bartholomew DJ, Steele F, Moustaki I, Galbraith J. Analysis of multivariate social science data. 2nd ed. Boca Raton: CRC Press; 2008.
25 Linda K. Muthén BOM. Mplus User's Guide. 6th ed. Los Angeles; Muthén & Muthén; 2010.
26 Horn JL. A rationale and test for the number of factors in factor analysis. Psychometrika. 1965;30:179-85.
27 Ledesma RD, Valero-Mora P. Determining the number of factors to retain in EFA: an easy-to-use computer program for carrying out Parallel Analysis. Pract Assess Res Eval. 2007;12:2.
28 Hais JF Jr, Black BC, Babin BJ, Anderson RE. Multivariate data analysis: global edition. 7th ed. London: Pearson Education; 2010.
29 Monk TH, Buysse DJ, Reynolds CF 3rd, Berga SL, Jarrett DB, Begley AE, et al. Circadian rhythms in human performance and mood under constant conditions. J Sleep Res. 1997;6:9-18.
30 Horne JA, Brass CG, Petitt AN. Circadian performance differences between morning and evening 'types'. Ergonomics. 1980;23:29-36.
31 Giannotti F, Cortesi F, Sebastiani T, Ottaviano S. Circadian preference, sleep and daytime behaviour in adolescence. J Sleep Res. 2002;11:191-9.
32 Wrzus C, Hänel M, Wagner J, Neyer FJ. Social network changes and life events across the life span: a meta-analysis. Psychol Bull. 2013;139:53-80.
33 Hofman MA. The human circadian clock and aging. Chronobiol Int. 2000;17:245-59.
34 Sturman DA, Moghaddam B. The neurobiology of adolescence: changes in brain architecture, functional dynamics, and behavioral tendencies. Neurosci Biobehav Rev. 2011;35:1704-12.
35 Carskadon MA, Vieirra C, Acebo C. zssociation between puberty and delayed phase preference. Sleep. 1993;16:258-62.
36 Lee PA. Normal ages of pubertal events among American males and females. J Adolesc Heal Care. 1980;1:26-9.
37 Merikanto I, Partonen T, Paunio T, Castaneda AE, Marttunen M, Urrila AS. Advanced phases and reduced amplitudes are suggested to characterize the daily rest-activity cycles in depressed adolescent boys. Chronobiol Int. 2017;34:967.
38 Haraden DA, Mullin BC, Hankin BL. Internalizing symptoms and chronotype in youth: a longitudinal assessment of anxiety, depression and tripartite model. Psychiatry Res. 2019;272:797-805.
39 Dahl RE, Ryan ND, Matty MK, Birmaher B, Al-Shabbout M, Williamson DE, et al. Sleep onset abnormalities in depressed adolescents. Biol Psychiatry. 1996;39:00190-5.